Karst in Southeast Michigan

A multi-year (2001 to present) educational initiative of the Monroe-Lenawee- Washtenaw Groundwater Stewardship Program

by Ned Birkey
MSU Extension Monroe County

What is a sinkhole?

A sinkhole is a natural depression in the landscape caused by solution and subsidence of earth materials.

Some local influences on Ground-water Quality

A. Rural and older septic systems and highly fertilized lawns in residential areas
B. Pesticides, fertilizers, manure and biosolids in agricultural areas
C. Roads, railroads, pipelines and industry
D. Geology, especially soft bedrock at or near the soil surface
E. Shallow well depth and ground-water age

Water and water quality questions

- What is karst?
- What is the risk to drinking water?
- What type of contamination has been found in our drinking water (in our area)?
- How has dye tracing been used? Results?
- Where are high risk areas located?

Why the concern?

- The hollow nature of karst terrain results in a very high pollution potential of water.
- Streams and surface water (runoff) entering sinkholes or caves bypass natural filtration through the soil.
- This "filtration bypass" provides a direct conduit for contaminants to travel some distance without filtration or purification.

Groundwater use for drinking in Monroe County

Source of drinking water in Monroe County according to the 1990 U.S. Census.

- 14,102 households using drilled wells for drinking water (29%)
- 1,442 households using dug wells for drinking water (3%)
- 593 households using "other" wells .01%
- 32,171 households using public water 67%

(48308 Total households)

What is Karst?

Karst is defined as a landscape with topographic depressions such as swallows, sinkholes or caves, caused by underground solution of limestone or dolomite bedrock.

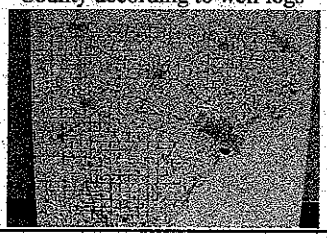
The Importance of Groundwater

The major groundwater issues in the Great Lakes' Region revolve around:

1. The quantity of groundwater,
2. Groundwater and surface-water interaction
3. Changes in groundwater quality as development expands, and
4. Ecosystem health in relation to quantity and quality of water.

source: The Importance of Groundwater in the Great Lakes Region, USGS Report 00-4008

Water well locations in Monroe County according to well logs



Where in the world is karst? Do we have karst in the U. S.?

Karst regions, areas underlain by limestone, dolomite, marble, gypsum and salt constitute about 25 percent of the land surface of the world.

Major karst areas occur in 20 states and numerous smaller karst regions throughout.

40 percent of the groundwater used for drinking comes from karst aquifers in the United States.

We live in a karst area

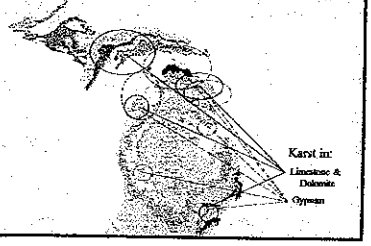
Monroe and Lenawee counties:

- have limestone and dolomite bedrock at or near the soil surface
- have sink holes
- have springs and flowing "artesian" wells
- have at least one "blue hole" at Lake Erie

Current Local Partners

- Monroe-Lenawee-Washtenaw Groundwater Stewardship Team
- Monroe Conservation District
- Lenawee Conservation District
- Monroe County Planning Commission
- Monroe County Env. Health Dept.
- Monroe County Drain Commission
- Monroe County MSU Extension
- Monroe County Farm Bureau

Michigan Bedrock Geology



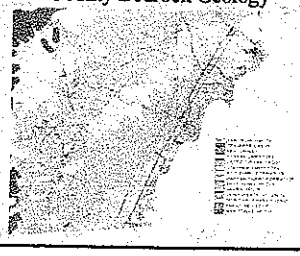
Karst committee of the Groundwater Stewardship Team

- **Ned Birkey, Chair**
- **Amy Gilhouse, GST**
- **Lea Cox**
- **Bill Basch**
- **Catherine Pigott and Marlene Rogers of Monroe Co SWCD**
- **Barbara Rybczynski**
- **Elizabeth Cafego**
- **Lisa Perschke, AmeriCorp**
- **Dr. Rane Curl, U of M**
- **Al Norwood, USDA NRCS**
- **Keith Siebarth**
- **Royce Manike, Monroe Co. Planning Dept**
- **Andy McCain, Monroe Co. EHD**
- **Robert Abar, Monroe County Drain Comm.**

Karst sub-committee goals

- Awareness of karst by public officials and the general public
- Secure local partners to help with grant proposals for study of local karst areas
- Secure grants to better identify and rank karst areas in Monroe and Lenawee counties

Monroe County Bedrock Geology



Ex- Officio Karst liaisons

- Dave Westjohn, USGS
- Ty Black, MDEQ
- Ruth Kline-Robach, MSU
- Lois Wolfson, MSU
- Ginger Bardenhagen, Michigan Dept Ag
- Andrea Kline, The Nature Conservancy
- Larraine Dressel, Whiteford Township Trustee
- Allison MacArthur Ruesink, MDEQ

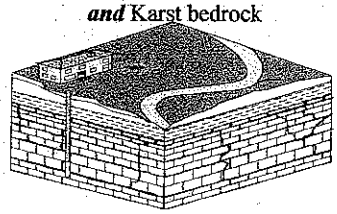
Karst sub-committee goals . . . .

- Assist township and county officials and land developers with the identification of karst areas and the relative hazards of individual karst areas for land use planning
- Produce an educational booklet about Living on Karst for Michigan landowners
- Produce an educational display and presentation (video) about karst

USGS, MDEQ, Monroe County EHD, MSU, Township (grants)

- To identify and map karst areas of Monroe and Lenawee counties
- To conduct dye tracing water movement
- Ideally rank karst areas as to their potential vulnerability to contamination
- To provide water quality testing to residents with well water in suspected karst areas

Home with pond, stream, well ***and*** Karst bedrock

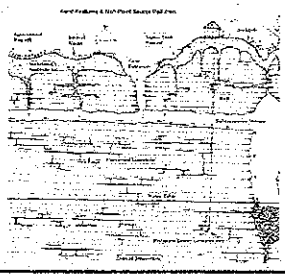


Monroe County Geological References

I. W.H. Sherzer, Geological Report on Monroe County, Michigan (Michigan Geological Survey, vol. 7, 1900)

II. A.J. Mozola, Geology for Environmental Planning in Monroe County, Michigan (Michigan Geological Survey Report Investigation 13, 1970)

Karst Relationship to Surface



Monroe County References cont.

III. W.J. Michno, Location and Identification of Sinkholes, Artificial Sumps and Their Contribution to Groundwater Pollution, Whiteford Township, Monroe County, MI (April, 1972 thesis, Eastern MI University)

IV. Siting the Superconducting Super Collider in Michigan, State of Michigan proposal, 1987, volume 3, Geology and Tunneling

V. Hydrology, Water Quality and Effects of Drought in Monroe County, Michigan USGS Report 94-4161

Sinkhole drains into groundwater

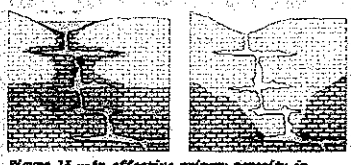
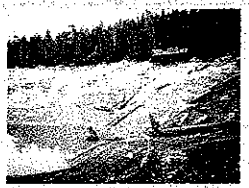


Figure 13.--An effective primary porosity in carbonate rocks results in added ground-water storage.

Devils Lake Sinkhole

Alpena County



Geological References continued

VI. Guidelines for Wellhead and Springhead Protection Area Delineation in Carbonate Rocks, US EPA, Region 4, 904-B-97-003

VII. Ground-Water Quality and Vulnerability to Contamination in Selected Agricultural Areas of Southeastern Michigan, Northwestern Ohio and Northeastern Indiana, USGS, Water-Resources Investigations Report 00-4146

Professor Sherzer's report

- Published in 1900
- Mapped eight larger sinkholes
- Noted many unnamed depressions less than ten feet deep.
- Photos, maps and illustrations included

Water quality concerns

- Wells going dry from low re-charge of the shallow aquifers in the groundwater
- Sulfur water in deeper aquifers
- Karst geography (bedrock and soil surface)
- High population and intensive agriculture
- Some homes use water holding tanks
- Poor soil conditions for septic systems
- Lake Erie water quality
- roads, pipelines, railroads, nuclear power plant, airports, seaports and spills

Water quality problems in Monroe County

- Hard: 10x of "normal" hard water
- Sulfur: deeper aquifers have more sulfur
- Black: generally the highest level of sulfur
- Turbid: when wind is strong from the east and Lake Erie is all stirred up

Michno report on Whiteford Twp

- More than 100 sinkhole locations mapped in Whiteford Township
- Ottawa Lake was a sinkhole "lake"
- Big Sink and Little Sink are very active
- Sinks vary in depth from 1 to 25 feet deep and 2 to +100 feet across

Contaminants found in Monroe County groundwater samples

Previous water samples in Monroe County have found the following "contaminants"

- **Pesticides, such as atrazine**
- **Fecal bacteria and other forms**
- **Inorganic chemicals such as nitrates, nitrites, and mercury**
- **Organic chemicals such as sulfur, iron, copper, zinc and manganese**
- **Benzine and Toluene**
- **Water softener discharge**

Monroe County and groundwater

Most townships of Monroe County have one or more of:

1. **sinkholes;**
2. **artesian wells;**
3. **quarry (new or old)**
4. **springs;**
5. **drain wells**

Whiteford Township Area

Water use in Monroe County

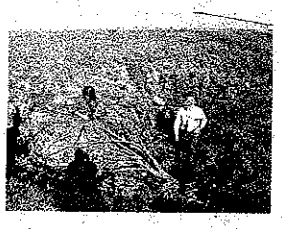
USGS estimates groundwater use at 30 million gallons per day

- 20 million gallons of de-watering by quarries
- 1 million gallons by agriculture
- 5 Million gallons by industrial
- 4 Million gallons by residential

Artesian well in eastern Monroe

- Artesian well in eastern Monroe County which has produced water since the well was drilled in 1937.
- It was used for livestock watering and a lawyer's coffee!

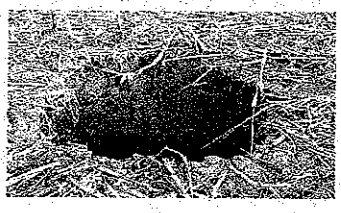
Sink hole by a road



Sinkhole in a county drain

Big Sink in the Fall

Sinkhole in southwest Monroe



Sinkhole under a county road

Looking east from Big Sink

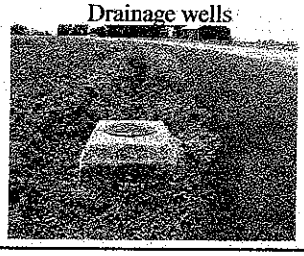
Sinkhole in northeast Monroe

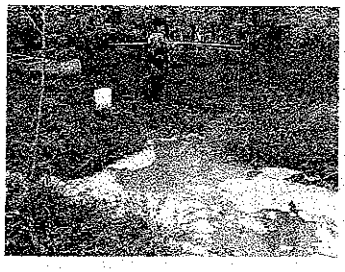
Big Sink in the spring

stream flowing west toward Sink

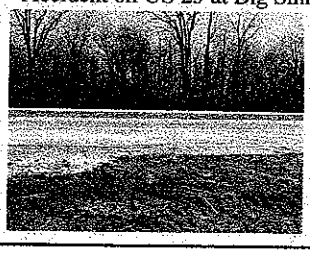
Sinkholes in Plum Creek

Ag and Road Commission Drainage wells





Accident on US 23 at Big Sink

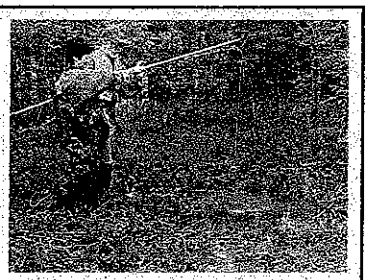


2001 Dye Tracing Project at Big Sink

- green Flourescein dye was put into Big Sink on Thursday, May 17
- 18 volunteers put dye trap "bugs" in their water to detect if any dye was present
- 19th bug in Widgeon Spring on Lake Erie

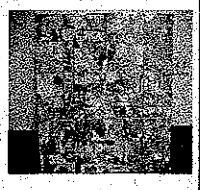
Great Sulphur Spring at the Lake Erie Marsh

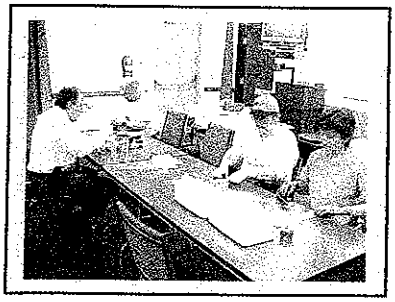
- "blue hole" near Lake Erie in The Nature Conservancy marsh
- bug was put in the outlet in 2001 and 02
- outlet flow estimated at 100 gal/ second



2002 Dye Tracing Project at Big Sink again

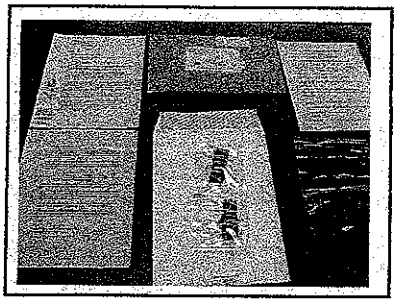
- 326 homeowners targeted within 2 miles of Big Sink
- Dye put in May 31
- 90 participants
- Positive results in the southwest of Big Sink





Updated Karst committee goals

- Water test of wells surrounding Big Sink
- Secure a grad student for water quality work
- Further committee and public official education
- Summer intern or 4-H to GPS sinkhole sites
- Donation of land surrounding Big Sink
- Education of realtors and others



What happened after 2 years?

2001	2002
Organize, secure members and set goals	Winter Public officials educational meeting
Conduct an Public Officials educational meeting	Second summer Public officials tour
Public Officials tour	Larger dye trace project of Big Sink
Presentation to all township and county planning commissions	Committee education
Dye trace Big Sink	Fall public educational meeting
Committee education	
Part time summer help	

2003 Dye trace in Wittkop Drain

- Citizen concerned about farm field runoff going into the drain and near his rural well.
- Water sample confirmed bacteria.
- Dye trace of his and neighbor's wells.

2002 Dye Trace Project

What have we learned in the past two years in southeast Michigan?

- We have reviewed previously published karst documents.
- We have identified old and new karst features.
- Townships and other land use planners would like a karst area risk map for master plans.
- We have made the public aware of this type of bedrock geology.
- We are helping educate people about groundwater use and protection.
- Groundwater flows in several directions and at various levels of the bedrock.

2003 Wittkop dye trace project

- 13 neighbors put bugs into their toilets
- We suspect the groundwater flows in a northeast direction
- There are numerous sinkholes in Plum Creek, Burwitz Drain and Wittkop Drain
- Monroe Co Drain Commission put cement into a nearby sinkhole in 1980

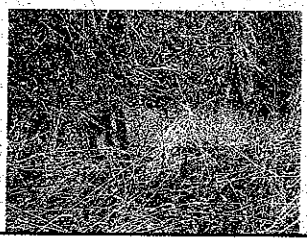
Water sample taken at home

Burwitz Drain and site of cement

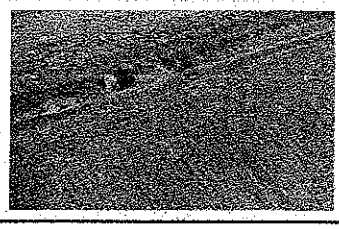
Small sinkhole in Burwitz Drain

Dye tracing Wittkop Drain 2003

Water in Burwitz Drain



2004 Project of Sinkholes in Plum Creek north of Ida



Aquifer Zone Protection

Casing and Sealing of Wells

Upper soils

Bedrock

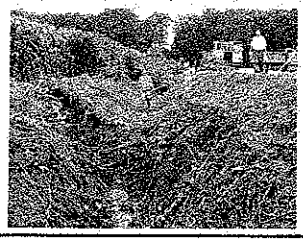
Fractured and karst featured

Solid

No water in Burwitz Drain

2004 Dye trace of Plum Creek

Plum Creek erosion of streambed



Putting fill into the hole

Understanding karst is important

Though some areas have karst features, ***all areas*** of Monroe County have people who use wells for drinking water.

Unless watersheds are protected, these direct connections between the surface water and subsurface (groundwater) can threaten the quality of our drinking water.

October 2004 Public demonstration at Plum Creek

Ground Water Concerns

Water well:
1. installation
2. maintenance
3. abandoned
4. Records

water quantity and quality

Transportation, Industrial, Residential
1. leaks
2. spills
3. waste disposal
4. septic fields

Excavate sinkhole to bedrock

N.E. L.P. Karst Risk Area Map